10. Discounting the future

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SUMMARY

Growth of per capita welfare, rooted in the productive nature of the economy, legitimates discounting. Given this rationale for discounting, there seems no reason to ask any generation to allocate its investments for the benefit of future, richer generations. However, there are two caveats.

First, uncertainty about future growth means that the discount rate should tend progressively towards the lowest possible growth rate. This is not time inconsistent, for as time passes it reduces uncertainties and legitimates changes in valuations and, therefore, decisions. In addition, if we are considering environmental damages that are so large that they are not marginal, their likely impact on economic growth would further justify a reducing discount rate.

Second, I argue that assets that are neither reproducible nor substitutable, such as some environmental assets, should be given a value that grows over time at a rate close to, but slightly lower than, the discount rate. This will lead to some 'effective discounting' and avoid the unbearable burden of an unlimited responsibility for current generations that would arise under zero discounting.

If these two suggestions are accepted, the present value of distant future environmental damages would not be rendered trivial by discounting.

10.1 INTRODUCTION

Discounting is probably one of the most disputed issues in economics. Current human activities may cause immediate and long-term environmental damages. Discounting, the usual procedure to give a present value to financial flows occurring in the future, seems to give outrageously low values to future damages, and thus, to disadvantage the environment and future generations. On the other hand, lowering discount rates would imply increasing sacrifices for the present generation, although future generations may be richer. Further, using various discount rates may lead to inefficiencies in selecting investment policies.

There are two different, but not unrelated, potential ways out of this dilemma. One may use decreasing discount rates, in particular to deal with uncertainty on future economic growth. One may also, in light of this discussion, assign non-substitutable, non-reproducible environmental assets a value that grows over time at a pace close to the discount rate itself.

The first section introduces discounting and its rationale. The second challenges the view that discounting might be considered unfair to future generations. The third section shows that the rate of return on investment cannot be higher than the growth rate of the economy in the long term. The fourth section reviews how uncertainty on future economic growth rates affects discount rates. The fifth section discusses the other side of the discounting issue – that of valuing environmental amenities and assets, as neither reproducible nor substitutable assets. The concluding section summarises and links the various arguments, and then draws some more general lessons from this analysis.

10.2 WHY DISCOUNT?

Discounting is a procedure that allows the computation of the present value of financial flows that will take place in the future. Discounting is needed in benefit-cost analysis to calculate net present values – the key criterion for investments. At a more global level, discount rates relate to investment rates: the lower the former, the higher the latter. As such, discounting reflects the balance between present and future well being.

As Irving Fisher established in 1930, discounting reflects both the productive nature of our economies and an individual's or society's impatience. The impatience element combines pure time preference and any expectation of rising per capita income, leading to decreasing marginal utility of consumption. In a world without market failure, tax and risk, one would write $i = r = \rho + \theta.g$ where i is the rate of return on investment, r the social rate of time preference, ρ the rate of pure time preference, θ the absolute value of the income-elasticity of marginal utility of income, and g the per capita growth rate. When taxes introduce a wedge between the social rate of time preference and the rate of return on investment, determining the appropriate discount rate is a complicated and somewhat controversial issue reflecting diverging views on the role of public and private investments in the economy. As riskier investments generally produce higher market interest rates, risk is also an element to consider when defining a discount rate from market interest rates. However, investments should not be selected from their 'rates for return', but from computing their 'net present values' (NPV) after considering all possible outcomes weighted by their probabilities of occurrence. Only one discount rate should be used. We will leave aside these discussions here (e.g., see Lind et al., 1982), simply noting that i is always considered as a maximum value for r.

We generally discount future amounts of money using a discount rate that is constant through time; that is, discount factors take the form $1/(1 + r)^t$. This is usually referred to as 'exponential discounting'. As a result, values in the far distant future are reduced to very low levels. For example, damages of €1 million 100 years hence have a present value of €52,000 at a discount rate of 3 per cent annually, and only €455 at a discount rate of 8 per cent. At his latter discount rate, the sum of an infinite series of discounted yearly fluxes of €1 equals €12.5, and the first forty years account for more than €12 of that; values beyond the first 40 years are essentially negligible in the present.

10.3 IS DISCOUNTING UNFAIR TO FUTURE GENERATIONS?

One often made argument is that discounting is 'unethical': people's welfare should not be valued less simply because they live at a different time. Pure time preference, or utility discounting, would be acceptable as far as it reflects individuals' choices – but not in an intergenerational context (e.g., see Pigou, 1920; Ramsey, 1928; Harrod, 1948; Solow, 1992). Thus, for example, Cline (1992) sets the rate of pure time preference to zero. This leads him to use a low discount rate (2 per cent) in computing the net present value of future damages arising from climate change. As a result, more near term mitigation action is warranted.

A shortcoming of this reasoning might be that in the same intergenerational context, the other component of the discount rate could need to be treated differently as well. Can it be the mere product of the per capita growth rate times the income elasticity of the marginal utility of income, when the income in question is not that of the same individuals? If future generations are richer than the current one, there is little justification of depriving additional money from the current, relatively poor generation in order to increase wealth of subsequent ones. In other words, if one chooses to be ethically prescriptive (Arrow et al., 1996) on pure time preference, consistency requires us to use a similar approach, but with opposite results, in relation to the wealth effect. For example, a Rawlsian maximin approach (Rawls, 1971) would give an infinite value to the coefficient θ, and hence to the discount rate, even though pure time preference would be prohibited.

Naturally, such a discount rate could only apply to investments having only intergenerational effects (but note this may well be the case of climate change mitigating investments, with very small near term effects).

More generally, discounting the future does not appear unethical, for if discounting utility of future generations might be, discounting their consumption might not be, provided per capita economic growth is real. As Baumol (1968, p. 800) wrote, 'a redistribution to provide more for the future may be described as a Robin Hood activity stood on his head – it takes from the poor to give to the rich. Average real per capita income a century hence is likely to be a sizeable multiple of its present value. Why should I give up part of my income to help support someone else with an income several times my own?' In this sense, an ethical appraisal of discounting does not conflict with Fisher's lesson: the productive nature of the economy legitimates discounting[1].

It is possible, however, that people receiving future benefits are not richer than those incurring current costs. For example, this might apply in the case of climate change; those more likely to reduce greenhouse gas emissions today are people in industrialised countries, while those more likely to benefit from reduced emissions in the future are the poor in developing countries lacking resources for adapting to climate change. Given the extent of disparity between developed and developing counties, people from developing countries in the future may well still be poorer than current people in developed countries. Therefore, neither of the two earlier arguments would justify positively discounting future costs of climate change: we have ruled out pure time preference, and the wealth effect would not apply either. However, does this mean that in case of climate change one should use a zero or even negative discount rate, as some have argued? (See, for example, Azar and Sterner, 1996.) Probably not; funds spent in climate change mitigation have opportunity costs, including the opportunity to directly improve current welfare in developing counties. It may be more efficient to devote the resources to development projects to help developing country people to achieve faster economic development. Climate change mitigation investments should thus compete with other development projects, using discount rates that are appropriate for projects in developing countries. Given the scarcity of capital, these are usually higher, not lower, than rates used in developed countries.

10.4 OPPORTUNITY COST

Discounting per se is not unfair, provided future generations are indeed richer. Indeed, discounting helps to ensure the greater wealth of future generation by allowing us to select efficient investments. This is the opportunity cost argument for discounting, and the World Bank response to Cline (1992) (Birdsall and Steer, 1993).

Rabl (1996) points out a difficulty here: the rate of return on marginal investment cannot be durably higher than the growth rate of the economy. This would lead to paradoxes: any investment, whatever small, but with a return rate greater than the growth rate of the economy would have, after enough time has elapsed, an output greater than the whole economy: clearly an absurdity. Over long periods of time, compound interest rates give dramatic results. One gram of gold saved with an interest rate of 3,25 per cent when Jesus was born would be worth today 6,000 billion, billion tonnes of gold – the weight of planet Earth (Crozet, 1994). This does not mean that marginal rates of return on investments cannot be higher, at any time, than the growth rate of the economy; part of the explanation for this is that the output of these investments are largely consumed, and only in part reinvested.

Benefit-cost analysis supposes that possible beneficiaries of the investment or policy under scrutiny could, in principle, compensate any losers. Discounting future damages (for example resulting from climate change) that could be avoided thanks to some investment (e.g., emissions mitigation) rests on the implicit hypothesis that alternative investments would have a rate of return at least equal to the discount rate used. However, rates of return higher than GDP growth rates cannot be sustained for ever. Thus, discount rates in the long run must come close to the growth rate of the economy. Rabl suggests a two-tier discounting procedure, using the conventional rate for a short period (30 years, for example) and then a reduced rate for intergenerational effects, equal to the rate of long term economic growth.

The first problem of that proposal is time inconsistency, as Solow (1999) notes after Ramsey (1928). Using Rabl's suggested approach, the value of a unit of capital in 2030, equal to the discounted sum of its future net benefits, will differ depending on whether it is calculated in 2000 or in 2030. A second problem is that the approach considers future growth rates to be exogenous. Such an assumption would not hold in the cases he considers; that is, when the outcomes of the investment are large enough not to be marginal. If an investment were made today with a high rate of return, and the proceeds continuously reinvested with the same high rate of return, a likely consequence would be the acceleration of economic growth. Conversely, if future damage from a decision made today were so high that no credible investment could compensate future generation, this damage would possibly slow economic growth, and even more likely, reduce the utility enjoyed by future generations. (This distinction may be relevant since many damages may indirectly increase GDP while reducing utility as, for example, car accidents do).

This leads, however, to consider another possible motive for using declining discount rates: the view that the economy itself is limited by our planet's carrying capacity. Sterner (1994) suggests that economic growth may follow a logistic curve leading to a steady state in the long run – say, ten times current GDP in 250 years. Rates of return on investment would thus decrease over time. Growth rate would start at 3 per cent then level off. Discount factors would be close to exponential discount factors in the first decades but then progressively depart from them, being kept forever to 1/10 after 250 years.

The approach proposed by Sterner is not time inconsistent. The value of a unit of capital in 2030 would be the same if computed today or in 2030 as long as the discount rate used in any future year can be specified in advance and remains unchanged when that year arrives (as implied by the logic of Sterner's proposal).

The view that the physical limits of the planet put a ceiling to the economy is, however, highly controversial. Weitzman (1999, p. 25) writes, 'technical progress, which is just a synonym for human ingenuity or inventiveness, prevents capital productivity from falling over time'. If our economy becomes less materialistic, it may not be constrained by the Earth's limits. The carrying capacity is usually defined as the maximum number of a species that can be supported indefinitely by a particular habitat, not their wealth.

10.5 UNCERTAINTIES

Even if we do not believe that our economy will be limited by the carrying capacity of the planet, can we entirely rule out that possibility? How sure are we that some environmental damages we are currently creating will not harm future growth? More generally, future growth rates and future rates of return on investment are uncertain, as is almost everything about the future. How should these uncertainties affect discount rates?

Let us imagine two states of the economy one hundred years hence. One corresponds to slow growth (for which a low discount rate is appropriate), the other to high growth (leading to a high discount rate). Let us consider them as equally probable. Let us now consider the present value of a sum of money from one hundred years hence. Using the standard approach of decision theory, it should be the weighted average of the net present values computed using the two discount rates. However, as noted by Weitzman (1998), this average is dominated by the value computed using the low discount rate (and is well above the NPV that would be computed using an average of discount rates). The reason is that in the high discount rate scenario, the present value is discounted to a trivially small level. As a result, if future growth is uncertain, the discount rate should come progressively closer to the 'lowest possible' discount rate.

For example, imagine that the growth rate of the economy is uncertain: it might be either 1 per cent or 3 per cent per year. (For sake of simplicity, we use constant discount rates equal to the growth rate.) We wish to calculate the present value of 100 euros 100 years hence. It comes to €37 in the low growth scenario, and €5 for high growth. Using (improperly) an average rate of 2 per cent, we would value this sum €14. If we suppose that the two states of the world have equal probabilities, the expected value of net present value is €21. To obtain this result with a single discount rate, we would need to use 1.6 per cent, not 2 per cent. More striking is what happens if one continues the thought experiment for one more year. The average net present value (with the same equal probabilities) after 101 years is €20,8. The appropriate discount rate is now about 1,25% – it gets closer to the lowest possible discount rate as time passes..

Newell and Pizer (2003) brought this insight to their study of uncertain discount rates. Their starting point was rates of return on investments, based on observed risk-free market rates. Over long periods of time they computed yearly benefits accruing from climate change mitigation. Results obtained using uncertain discount rates were compared with results obtained using a fixed discount rate set at the expected value of the uncertain distribution. Because unexpectedly low discount rates raise valuations by a much larger amount than unexpectedly high discount rates reduce them, uncertainty about the discount rate always raises the valuation of future benefits. Newell and Pizer (2003) concluded that effective discount rates should decline in the future to take uncertainty into account, in agreement with Weitzman (1999).

Using declining discount rates because of uncertainty would not be time inconsistent, although the value of a given unit of capital in 2030 as computed in 2000 may take a lower value in 2030. This value may legitimately change with the passage of time, for the latter progressively reduces the uncertainty on future growth rates (Philibert, 1999). In other words, behaviour that would be time-inconsistent in a deterministic world is legitimate state-contingent behaviour in a world with uncertain discount rates (Newell and Pizer, 2003).

10.6 SUBSTITUTABILITY, NOT DISCOUNTING, IS THE ISSUE

There seems to be a number of arguments for using declining long term discount rates. This is not, however, the end of the story. Thinking about discounting leads us to think more deeply about valuation of the environment in the future.

As Krutilla (1967, p. 783) wrote, ‘natural environments will represent irreplaceable assets of appreciating value with the passage of time’. How should this value grow over time? An extensive literature has looked at this point by trying to assess people’s willingness-to-pay for future environmental assets, with no clear answer emerging (e.g., see Fisher and Krutilla, 1974, 1975; Hanley and Spash, 1993; Desaigues and Point, 1993).

If, however, one considers that the real justification for discounting is the productivity of the economy rather than individual or social preferences, then one may link the valuation of environmental assets to the discount rate. Referring implicitly to the Hotelling rule (Hotelling, 1931) regarding the optimal use of non-renewable natural resources, Boiteux (1976, p. 830) writes that, ‘all economic models show that in a growing economy the prices of resources available in strictly limited quantities should be assumed to grow at an annual rate that is at least equal to the discount rate’. In his view, this rate could be even greater than the discount rate as a result of a growing preference for the environment. That hypothesis is not needed, according to this framework, to set the rhythm of increase in value equal to the discount rate: this only rests on the non reproducible nature of Nature. As a result, writes Boiteux (1976, p.831), ‘in the long run, the discounting process clears everything that is of secondary importance because it can be controlled by human proficiency, to stress what is essential: i.e., whatever is intrinsically scarce and cannot be reproduced’. In other words, if correctly valued (given values growing over time), the natural environment will not be disadvantaged by discounting, because discounting progressively erases the values of the fruits of man’s labor.

For Neumayer (1999a) also, discounting is not the issue – substitutability is. Valuing environmental assets in monetary terms rests on the assumption that environmental and other values are substitutable for each other. This assumption is at the heart of the ‘weak sustainability’ concept, but is unacceptable for advocates of of ‘strong sustainability’, who hold that natural capital should be kept intact. However, neither concept of sustainability can be falsified using scientific standards (Neumayer, 1999b).

While Krutilla’s approach may still be qualified as referring to the ‘weak sustainability’ paradigm, the Boiteux proposal is more ambiguous. It does not reject monetary valuation. However, giving any environmental asset a value growing over time at the pace of discount rate, eventually leads to the paradox discussed by Rabl: over time, this asset will be valued more highly than the rest of the economy. Weak at the onset, but rather strong over time! One consequence is that the destruction of an environmental asset (e.g., extinction of a species) would have the same present cost whenever it happens. Another is that discounting –whatever constant or decreasing, high or low – would not reduce distant future environmental damages to trivial levels. A third consequence is that delaying damages would have no value.

This seems an important omission since delaying irreversible damages leaves open the possibility that they will not happen due to technical progress or other developments.

In view of this, perhaps environmental assets that are neither reproducible nor substitutable should be given a value growing over time at a rate close to, but slightly less than, the discount rate. As a result, environmental assets would be submitted to what Fisher and Krutilla (1975, p.359) called 'effective discounting', but at a very low rate, which we might call 'slow effective discounting'.

Lack of effective discounting would give the current generation an unlimited responsibility with respect to future generations, which seems a problem in itself: strong sustainability might be too strong. As argued by Ricœur (1995, p. 68), 'Completely ignoring the side effects of the action would make it dishonest, but unlimited responsibility would make it impossible. It is indeed a sign of human limitations that the disparity between the desired effects and the innumerable consequences of the action is itself unmanageable, and calls upon the practical wisdom gained throughout the history of earlier trade-offs. A happy medium must be found between escaping from the responsibility for consequences and the inflation of infinite responsibility'.

How would 'low effective discounting' of environmental assets be interpreted in terms of sustainability? Clearly it belongs to the weak sustainability paradigm. However, it does not hold damage to the environment to be negligible simply because it will happen in the future as a result of current action. As such, it helps to ensure that welfare will not decline over time – the requirement that weak sustainability adds to neo-classical economics.

10.7 CONCLUSION

Simple arithmetic suggests that discount rates higher than economic growth are not sustainable over the long. This, combined with inherent uncertainties about future economic growth, suggests that one may use declining discount rates.

As far as the environment is concerned, the most important point put forward here is that environmental assets that are neither substitutable nor reproducible should be given a value growing over time at a pace close to, but slightly less than, the discount rate. This would result in greater net present values for prevention of future environmental damage and, for example, may justify greater greenhouse gas mitigation efforts in the short term.

This also reinforces the arguments for declining discount real rates. Future environmental damages may, in this framework, become so large that they would likely shrink future welfare. This may justify an economic interpretation of the carrying capacity of the Planet or, at a minimum, stress the uncertainty on future economic growth. In both cases, declining discount rates would be warranted.

The proposal to grow the valuation of environmental assets over time has another important implication: assessment of the long-term consequences of current policies will likely be dominated by environmental values. But environmental assets are only marginally present on current markets, and thus, their monetary value is often hard to estimate. As a result, the present value of future environmental damage increases, while the uncertainty surrounding its estimation increases.

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NOTES

1. A related argument is the 'isolation paradox' exposed by Sen (1961, 1967) and Marglin (1963) and taken up by Broome (1992) in the context of climate change. Savings for future generations are partly public goods, likely to be undersupplied by free markets. For a discussion, see Philibert (1998).

REFERENCES

Arrow, K.J., W.R. Cline, K.-G. Maler, M. Munasinghe, R. Squitieri and J.E. Stiglitz (1996), 'Intertemporal equity, discounting, and economic efficiency', in J.P. Bruce, H. Lee and E.F. Haites (eds), Climate Change 1995 - Economic and Social Dimensions of Climate Change, Cambridge: Cambridge University Press, pp. 125-144.

Azar, C. and T. Sterner (1996), 'Discounting and distributional considerations in the context of global warming', Ecological Economics 19, 169–184.

Baumol, W.J. (1968), 'On the social rate of discount', American Economic Review 58, 788-802.

Birdsall, L.N. and A. Steer (1993), 'Act now on global warming - but don't cook the book', Finance and Development 30, 6-8.

Boiteux, M. (1976), 'A propos de la 'Critique de la théorie de l'actualisation'', Revue d'économie Politique 5, 828-831.

Broome, J. (1992), Counting the Cost of Global Warming, Cambridge, UK: White Horse Press.

Cline, W.R. (1992), The Economics of Global Warming, Washington D.C.: Institute of International Affairs.

Crozet, Y. (1994), Inflation ou Déflation ? Actualité d'un Dilemme, Nathan: Paris.

Desaigues, B. and P. Point (1993), 'Économie du patrimoine naturel', Economica, Paris.

Fisher, I. (1930), The Theory of Interest, New York: Kelley and Millman.

Fisher, A.C. and J.V. Krutilla (1974), 'Valuing long run ecological consequences and Irreversibilities', Journal of Environmental Economics and Management 1, 96–108.

Fisher, A.C. and J.V. Krutilla (1975), 'Resource conservation, environmental preservation, and the rate of discount', Quarterly Journal of Economics 89, 358-370.

Hanley, N. and C.L. Spash (1993), Cost-Benefit Analysis and the Environment, Aldershot, UK and Brookfield, US: Edward Elgar.

Harrod, R.F. (1948), Towards a Dynamic Economics, London: Macmillan.

Hotelling, H. (1931), 'The Economics of exhaustible Resources', Journal of Political Economy 39, 137-175.

Krutilla, J.V. (1967), 'Conservation reconsidered', American Economic Review 57, 777-786.

Lind, R.C., K.J. Arrow, G.R. Corey, P. Dasgupta, A.K. Sen, T. Stauffer, J.E. Stiglitz, J.A. Stockfisch and R. Wilson (eds) (1982), Discounting for Time and Risk in Energy Policy, Baltimore, MD: John Hopkins University Press for Resources for the Future.

Marglin, S.A. (1963), 'The social rate of discount and the optimal rate of investment,' Quarterly Journal of Economics 77, 95-111.

Neumayer, E. (1999a), 'Global warming: discounting is not the issue, but substituability is', Energy Policy 27, 33-43.

Neumayer, E. (1999b), Weak versus Strong Sustainability: Exploring the Limits of Two Opposing Paradigms. Cheltenham, UK and Northampton, MA, US: Edward Elgar.

Newell, R.G. and W.A. Pizer (2003), Discounting the distant future: how much do uncertain rates increase valuations? Journal of Environmental Economics and Management 46, 52-71.

Philibert, C. (1998), The isolation paradox and the climate change, mimeo, http://philibert.cedric.free.fr/Downloads/isolat.pdf

Philibert, C. (1999), 'The economics of climate change and the theory of discounting', Energy Policy 27, 913-929.

Pigou, A.C., (1920), The Economics of Welfare, London: MacMillan.

Rabl, A. (1996), 'Discounting of long term costs: What would future generations prefer us to do?', Ecological Economics 17, 137-145.

Ramsey, F. (1928), ‘A mathematical theory of saving’, Economic Journal 38, 543-559.

Rawls, J. (1971), A Theory of Justice, Cambridge, MA: The Belknap Press of Harvard University Press.

Ricœur, P. (1995), Le juste, Paris: Éditions Esprit.

Sen, A. K. (1961), ‘On optimising the rate of saving’, Economic Journal 71, 479-496.

Sen, A.K. (1967), ‘Isolation, assurance, and the social rate of discount’, Quarterly Journal of Economics 81, 112-124.

Solow, R.M. (1992), An almost practical step toward sustainability, Resources Policy 19, 162-172.

Solow, R.M. (1999), ‘Foreword’, in Portney P.R. and J.P. Weyant (eds), Discounting and Intergenerational Equity, Washington D.C.: Resources for the Future, pp. vii-ix.

Sterner, T. (1994), ‘Discounting in a world of limited growth’, Environmental and Resource Economics 4, 527-534.

Weitzman, M.L. (1998), ‘Why the far-distant future should be discounted at its lowest possible rate’, Journal of Environmental Economics and Management 36, 201-208.

Weitzman, M.L., (1999), ‘Just keep discounting, but …’ in P.R. Portney and J.P. Weyant (eds), Discounting and Intergenerational Equity, Washington D.C.: Resources for the Future, pp. 23-29